Modelling Blue to UV Upconversion in β-$NaYF_4$: 0.3% Tm^{3+}

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The decay curves of Tm^{3+}-doped β-$NaYF_4$ contain sufficient information to determine the internal energy transfer steps responsible for the upconverted UV luminescence after blue excitation.

Although several models have been developed to analyse upconversion processes, none of them are able to both take into account all energy transfer interactions, including energy migration, and offer a microscopic picture of them.

A recently published model calculates all energy transfer interactions according to the distances between the ions in a lattice and assigns a rate equation system to each ion. The model outputs the decay curve of each relevant energy level.[1] These curves can be then compared to the experimental ones, and the energy transfer parameters can be determined from the fit.

In Figure 1, two energy transfer interactions cooperate to populate the Tm^{3+} $^1D_2$ state in a β-$NaYF_4$: 0.3% Tm^{3+} sample. The model is able to reproduce the experimental data and determine the critical radius of the interactions.

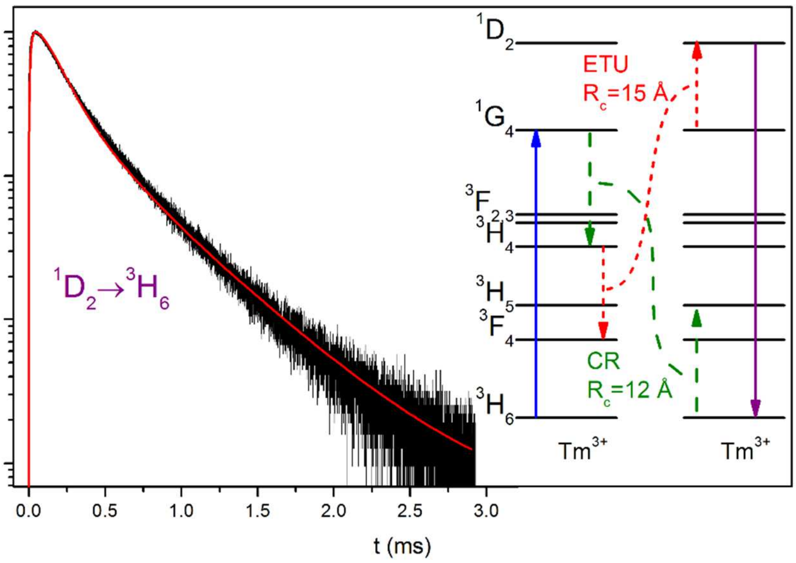

Figure 1: Experimental (black line) and simulated (red line) decay curve of the $^1D_2 \rightarrow {}^3H_6$ transition in β-$NaYF_4$: 0.3% Tm^{3+} and energy level scheme with interactions.

References:

[1] Villanueva-Delgado, P.; Krämer, K. W.; Valiente, R.; *J. Phys. Chem. C* 119 (2015) 23648.